Pol. J. Environ. Stud. Vol. 31, No. 5 (2022), 4331-4342
DOI: *10.15244/pjoes/148068* ONLINE PUBLICATION DATE: 2022-07-14

Original Research

Does Environmental Regulation Intensity Affect the Financial Risk of Manufacturing Enterprises? Evidence from China

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Received: 29 January 2022
Accepted: 5 April 2022

Abstract

As a significant policy measure to protect the environment, environmental regulation can constrain enterprises' production and operation activities in the long run. However, no clear conclusions have been made about the impact of environmental regulation intensity (ERI) on enterprises' financial risk. This study tests the empirical relationship between ERI and manufacturing enterprises' financial risk by using a bidirectional fixed effects model with listed manufacturing enterprises in China from 2012 to 2016. It is found that ERI has a significant negative effect on the financial risk of manufacturing enterprises, and this result remains significant after robustness tests. Further study finds that the effect of ERI on the financial risk of manufacturing enterprises is not significant in the sub-sample of private, low-polluting, and first-tier cities manufacturing enterprises; in the sub-sample of non-private, high-polluting, and non-first-tier cities manufacturing enterprises, ERI has a significant negative effect on their financial risk. Our discoveries provide empirical evidence and theoretical references for manufacturing enterprises to improve their ability to analyze the exogenous environment to avoid endogenous financial distress and provide intellectual support for the government to optimize environmental regulation policies.

Keywords: financial risk, environmental regulation intensity, manufacturing enterprise, ownership

Introduction

Since the reform and opening-up, China's economy has continued to grow at a high rate. However, the rapid development has revealed a series of environmental problems arising from manufacturing enterprises in the production and operation process, and the crude production methods of high input, high consumption, and high pollution are hardly compatible with the goal of high-quality economic development [1]. Even though China has resolved to promote the development of resource-saving and environment-friendly manufacturing industries in recent years, the problems of tight resource constraints and environmental

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pollution are still very serious. To ameliorate the serious environmental problems, the government has issued a series of increasingly stringent environmental regulations to regulate the pollution discharge and pollution control behaviors of enterprises [2]. As a result, the environmental protection investment cost of manufacturing enterprises has increased substantially. This additional cost has exacerbated the financial risk of enterprises to some extent. In-depth research on the impact of environmental regulation intensity (ERI) on financial risks of manufacturing enterprises is meaningful, which is conducive to exploring the balanced development model of enterprise development and environmental protection and is also an important theme to promote high-quality development of the manufacturing industry.

From the existing literature, although the impact of ERI on enterprises has been a hot issue in the management field, the existing research mainly focuses on the exploration of the following two topics. One is the research on ERI and environmental protection investment behavior of enterprises. Under strict environmental regulation, some enterprises tend to choose "pollution refuges", while other enterprises choose to make environmental protection investment, such as pollution control investments or innovation investments. The relationship between ERI and enterprise innovation is controversial, with a positive correlation [3, 4] and the negative correlation [5], and the nonlinear correlation [6]. The other is the research on ERI and enterprises' economic performance, in terms of specific indicators, have mainly examined the intrinsic association between ERI and productivity [7] or ERI and financial performance[8]. Unfortunately, few studies have paid great attention to the impact of ERI on the financial risk of manufacturing enterprises. So, does ERI increase the financial risk of manufacturing enterprises? Is there any heterogeneity in the adverse impact of ERI on the financial risks of manufacturing companies?

To answer the above questions, the paper conducted relevant research using a bidirectional fixed effects model with a sample of listed manufacturing enterprises in China from 2012 to 2016. Research results turn out that: (1) ERI has a significant negative effect on the financial risk of manufacturing enterprises, and (2) the negative effect of ERI on the manufacturing enterprises' financial risk is more significant in the subsample of non-private, high-polluting, and non-first-tier cities manufacturing enterprises. Compared with previous studies, the possible marginal contributions of this study are the following two: (1) This study measures the intensity of environmental regulation at the manufacturing industry level and examines its impact on the financial risk of manufacturing enterprises, which enriches and expands the research on the impact of environmental regulation on the business conditions of enterprises. (2) This study further explores the impact of ERI on the financial risk of manufacturing enterprises with different ownership types, pollution intensity, and city's economic level, which can provide a basis for the government to adjust environmental regulation policies in a targeted manner, thus helping to promote a "win-win" situation for both environmental protection and enterprise development.

The rest of the paper is structured as follows: Section 2 shows the literature review; Section 3 presents the research hypotheses; Section 4 introduces the design of the empirical study; Section 5 describes the results of the panel regression, robustness test, and heterogeneity test, and discusses the main empirical results; Section 6 conducts the conclusion and related recommendations.

Literature Review

At present, there is little literature directly studying the impact of ERI on the financial risk of manufacturing enterprises, however, relevant studies provide guidance and experience for this study from the following two aspects. First, the impact of ERI on enterprise profitability and financing constraints, and second, the impact of government regulations on enterprise financial risk.

The profitability and financing ability of enterprises are important internal factors affecting the financial risk of enterprises. Scholars have conducted relevant studies around the question of whether ERI affects enterprise profitability, which can be summarized into three categories: (1) ERI has a positive relationship with enterprise profitability; (2) ERI has a negative relationship with enterprise profitability; (3) the impact of ERI on enterprise profitability is uncertainty.

Studies that support the idea that ERI has a positive relationship with enterprise profitability suggest that strict yet reasonable environmental regulation can stimulate enterprise innovation, and the resulting "innovation compensation effect" can reduce or even offset the costs of environmental regulation, thus enhancing the profitability of enterprises [3, 4]. However, studies supporting the idea that ERI has a negative relationship with enterprise profitability have refuted mainly in terms of environmental regulation increasing enterprises' environmental capital investment and environmental regulation reducing enterprises' innovation output: (1) Environmental regulation forces enterprises to make environmental protection investments that incur additional costs and crowd out R&D investment [9], thus causing a misallocation of enterprise resources. This inhibits the improvement of the overall profitability of the enterprise. (2) Enterprises' innovation output is also limited under environmental regulatory constraints, and the "innovation compensation effect" is often difficult to offset the "compliance cost effect" [8], thus weakening enterprises' profitability. In addition, some studies have made the point of the uncertainty of the impact of ERI on enterprises' innovation performance.

This uncertainty depends on regional differences or the type of ownership natures [8], or the type of environmental innovation [10], etc. Moreover, the effect of ERI on enterprises' innovation performance may not be simply linear but non-linear [11]. Therefore, the impact of ERI on enterprise profitability is uncertain.

Previous studies have also made useful attempts on the impact of ERI on enterprises' financing constraints. Some studies have argued that environmental regulation stimulates or compels enterprises to disclose environmental information, which can effectively alleviate the information asymmetry between investors and enterprises, increase investors' willingness to invest, and enable enterprises to obtain more low-cost financing [12]. However, under environmental regulation constraints, information about enterprises' failure to meet environmental regulation standards and violations of environmental regulation is also disclosed more frequently. The disclosure of such negative information reduces investors' willingness to invest. Thus, the financing constraints of enterprises are strengthened [13]. Moreover, under environmental regulation, green credit policy has a significant financing penalty effect on heavily polluting enterprises, and heavily polluting enterprises face stronger financing constraints [14]. In summary, it can be observed that existing studies have extensively explored the relationship between ERI and enterprise profitability and financing constraints, but studies on the impact of ERI on enterprise financial risk are extremely rare.

Among the studies on the influencing factors of enterprise financial risk, government regulation and its specific initiatives have been extensively discussed, which can provide some reference for this study. It has been found that both strong government regulation and industry competition deepen the financial risk of individual enterprises [15]. In contrast, some scholars found that the stronger the government regulation, the lower the enterprise financial risk, and the economic regulation has a more significant effect on controlling enterprise's financial risk than social regulation [16]. In particular, some scholars focus on the influence of soft budget constraints on corporate financial risk. The soft budget constraint refers to a phenomenon that the government provides subsidies, favorable price policies, and increased preferential credit when state-owned incur losses to bailout enterprises in socialist economies [17]. To some extent, the soft budget constraint reduces the financial risk of enterprises. Conversely, as the budget constraint hardens, the likelihood of enterprises facing bankruptcy liquidation increases [18]. Some scholars argue that the level of financial development [19], ownership type [20], etc., may differentially affect the strength of the budget constraint faced by enterprises, which further affects the financial risk of the enterprise. Government ownership became an umbrella to avoid the financial distress of enterprises in the financial crisis [21]. By softening budget constraints, the government has bailout enterprises owned by the government. However, some studies have indicated that government ownership is harmful to enterprise performance [22], implying that government regulation increases enterprise financial risk.

From the available studies, scholars have discussed the impact of ERI on enterprise profitability and enterprise financing constraints, but there is little literature that directly relates ERI to the financial risk of manufacturing enterprises. In addition, studies on the impact of government regulation on the financial risk of enterprises start from the intensity of government regulation, types of government regulation, and specific regulatory instruments, while little research has been done on environmental regulation, an important component of government regulation. In this context, this study will deeply explore the empirical relationship between ERI and manufacturing enterprises' financial risk and provide new empirical evidence for the study of the effect of environmental regulation policies.

Research Hypothesis

ERI and Financial Risk of Manufacturing Enterprises

Enterprise financial risk refers to the uncertainty of the financial position in the process of various financial activities due to various unpredictable or uncontrollable factors, and thus the possibility of loss to the enterprise. In the financial activities of enterprises, once investment mistakes occur, it will bring significant economic losses to the enterprise, and more seriously will cause the enterprise bankruptcy and liquidation. At the same time, the rising cost of production and operation directly affects the enterprise liquidity risk. And, the financing constraint has an important impact on the cost of capital for enterprises. The stronger financing constraint is an important external reason for enterprises to fall into financial difficulties. Environmental regulation, as an external shock to enterprises' production and operation activities, directly or indirectly affects their financial activities such as enterprise investment, production and operation, and financing. Therefore, examining the impact of ERI on enterprise investment, production and operation costs, financing constraints, etc. is an important breakthrough to study the impact of ERI on enterprise financial risk.

The effect of ERI on enterprise investment is reflected in the fact that strict environmental regulation forces companies to take action to treat and control pollution, which results in environmental investment costs. However, environmental investment is mostly a high-risk project with a large capital scale, long time, and uncertain expected returns [23]. In addition, the costs of strict environmental regulation may be higher than the benefits of investing in new technologies [24], which leads to a reduction in profitability and solvency, thereby increasing the financial risk of enterprises.

The effect of ERI on the cost of production and operation of enterprises is reflected in the fact that, on the one hand, enterprises actively cater to environmental regulation, which will increase the cost of pollution control [5], directly increasing the cost of production and operation of enterprises. On the other hand, enterprises responding to ERI passively (e.g., not implementing or even violating environmental regulation) will passively be subjected to more environmental pollution penalties, which also increase enterprises' production and operation costs. And, stronger ERI may raise the environmental quality standards and market access standards for enterprises' products, and products that fail to meet the standards will face the risk of backlogs, resulting in higher inventory costs and lower corporate liquidity, which exposes enterprises to greater financial risk.

The effect of ERI on enterprises' financing constraints is reflected in the increased sensitivity of stakeholders to enterprises' environmental performance under environmental regulation [25]. With the enhancement of ERI, investors receive more negative signals that enterprises are violating environmental regulation policies. The disclosure of risk information enhances investors' risk perceptions [26]. Once external investors expect risks in the future operation and development of the enterprise, investors tend to recover their investment funds on time [27], or by increasing the expected return rate to make up the additional environmental risks. This is expected to result in higher financing costs and increased financial risk for the enterprise.

Accordingly, we propose the first hypothesis:

Hypothesis 1. ERI has a significant negative effect on the financial risk of manufacturing enterprises.

ERI and Financial Risk of Manufacturing Enterprises: Differences in Ownership Type

Enterprises with different ownership types differ significantly in their business areas, their response to policies, and their tolerance to policy shocks. Therefore, the impact of ERI on the financial risk of enterprises with different ownership types may differ. In China, the "quasi-governmental" nature of non-private enterprises places a higher social responsibility on them than on private enterprises, and their operations are non-market-oriented. Private enterprises, on the other hand, have more flexibility in adjusting their investment direction based on the goal of profit maximization, and the effect of environmental regulation on private enterprises may be weakened. Therefore, non-private enterprises are under more pressure to reduce emissions under strict environmental regulation, which will most probably have more negative effects on their financial performance. In addition, non-private enterprises tend to be larger, and the cost of pollution control tends to increase in marginal size with the scale of the enterprise [28]. Hence, we put forward the second hypothesis:

Hypothesis 2. The negative effect of ERI on the financial risk of non-private manufacturing enterprises is more pronounced compared to private manufacturing enterprises.

ERI and Financial Risk of Manufacturing Enterprises: Differences in Pollution Intensity

Manufacturing enterprises with diverse pollution intensities are affected by ERI in terms of investment, production and operation costs, and financing differently. On the one hand, Heavy polluters have to bear more environmental protection investment costs, which increases the financial risk of enterprises [29]. On the other hand, from the perspective of environmental investment output, the marginal cost of pollution control is higher for high-polluting enterprises compared to low-polluting enterprises. Since the economic output obtained from their increased environmental factor inputs can hardly offset the increased cost of environmental regulation [30], the financial risk they face increases. And relatively speaking, the environmental performance of high-polluting enterprises is not satisfactory under strict environmental regulation, so their financing constraints are stronger; moreover, high-polluting enterprises are facing problems such as shutdown and reform, capacity removal, and bankruptcy and liquidation at any time [29], and their production and operation are highly unstable, making it more difficult to obtain financing and more likely to fall into financial difficulties. Therefore, the third hypothesis is proposed:

Hypothesis 3. The negative effect of ERI on the financial risk of high-polluting manufacturing enterprises is more pronounced compared to low-polluting manufacturing enterprises.

ERI and Financial Risk of Manufacturing Enterprises: Differences in City's Economic Level

Some scholars believe that the imbalance of regional economic development has led to spatial differences in ERI or environmental regulation effects [2]. Considering the obvious differences in the level of economic development between Chinese cities [31], this study distinguishes between first-tier cities and non-first-tier cities for sub-sample analysis according to the city level where the enterprises are situated. Specifically, first-tier cities, with their progress advantages, are better able to assist in the iterative upgrading of industrial structures and the development of more clean industries. As a result, manufacturing enterprises in first-tier cities are more environmentally coordinated and adaptable to environmental regulation. On the other hand, first-tier cities tend to have higher financial levels, diverse financing channels, better investment environments, and lower financing constraints, which enable enterprises to obtain more financing to improve their risk resistance. It can be deduced that the impact

of ERI on the production and operation activities of manufacturing enterprises in first-tier cities is relatively small. However, non-first-tier cities (cities with less comprehensive development) are "pollution refuges" that take over the transfer of heavy polluters from first-tier cities, and they are more likely to continue to adhere to the traditional economic development model of "pollution first and treatment later" environmental regulation has a more pronounced restrictive effect on the production and operation activities of enterprises in non-first-tier cities, which may increase the financial risk of enterprises. This is the fourth hypothesis:

Hypothesis 4. The negative effect of ERI on the financial risk of manufacturing enterprises in non-first-tier cities is more pronounced compared to manufacturing enterprises in first-tier cities.

Methodology and Data

Model Design

In order to explore the empirical relationship between environmental regulation and manufacturing enterprises' financial risk, our study constructs the following equation.

$$Z\text{-}score = \beta_0 + \beta_1 ERI_{jt} + \beta_2 Control_{it} + \mu_i + \gamma_t + \varepsilon_{it}$$

Where the subscripts i, j, and t denote the enterprise, industry, and year, respectively; *ERI* is the abbreviation of environmental regulation intensity; and *Z-score* represents the enterprise's financial risk, which is measured by using the modified *Z-score*[1] by Altman [32]. In addition, we select a series of enterprise-level control variables (*Control*), including enterprise size, current ratio, asset cash recovery rate, enterprise growth capacity, independent director ratio, and equity concentration. μ_i refers to the individual fixed effects meaning control for the effects of unobserved factors of enterprise characteristics on enterprise financial risk; γ_t refers to the time fixed effects meaning control for factors that affect enterprise financial risk but only vary over time; ε_{it} is random disturbance term.

Variable Descriptions

Explained Variables

Z-score can judge the enterprise financial distress comprehensively. It is appropriate to measure the financial status of listed companies under the environment of the emerging capital market [33]. The specific calculation formula is as follows.

$$Z\text{-}score = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.42X_4 + 0.998X_5$$

Where, X_1 = working capital/total assets; X_2 = retained earnings/total assets; X_3 = *EBITDA*/total assets; X_4 = total market value of stocks/total book value of liabilities; X_5 = sales revenue/total assets. The larger the value of *Z-score*, the lower the financial risk.

Explanatory Variables

In this study, the ratio of the operating costs of wastewater and waste gas treatment facilities (*OC*) from the each manufacturing industrial to the corresponding manufacturing industrial sales values (*SV*), i.e., the operating costs of pollution treatment facilities per unit of manufacturing industrial sales value-added, is used as a measure of environmental regulation intensity (ERI) [34]. This indicator can well reflect that ERI plays an important role in the financial risk of enterprises. The specific calculation formula is as follows.

$$ERI = OC / SV$$

Control Variables

Based on the comprehensive consideration of previous research results, a series of enterprise-level control variables are selected in this paper, mainly including enterprise size; current ratio; asset cash recovery rate; business growth capacity; independent director ratio; and ownership concentration. The names, symbols, and assignment methods for all variables are shown in Table 1.

Data Source and Processing

The data in this paper comes from the China Stock Market & Accounting Research Database (CSMAR) and China Industrial Statistical Yearbook. When calculating the ERI index, it is necessary to use the data of three indicators: The operating cost of waste gas treatment facilities of each manufacturing industry, the operating cost of wastewater treatment facilities of each manufacturing industry, and the sales value of each manufacturing industry. However, the sales value of each manufacturing industry in the China Industrial Statistical Yearbook is only updated to 2016. Therefore, we cannot measure the ERI index after 2016. Due to data limitations, the latest data available can only be updated to 2016.

Specifically, our study selects listed manufacturing enterprises in China as the research object, and the panel data covers 29 sub-sectors in China's manufacturing industries during 2012-2016.

In this study, the initial data are processed as follows: (1) Delete samples with missing indicators and abnormal indicator sizes; (2) delete ST, *ST, S*ST, and PT listed companies because such listed companies may have abnormal financial status or another abnormal status, which may cause bias in the research results;

Table 1. Variables and their definition.

Variable type	Variable name	Symbol	Measurement
Explained variables	Financial risk dummy variable	*Z-score*	$Z\text{-}score = 0.717X_1 + 0.847X_2 + 3.107X_3 + 0.42X_4 + 0.998X_5$
Core explanatory variables	Environmental regulation intensity	*ERI*	*OC / SV*, unit: 100 RMB / 10, 000 RMB
Control variables	Enterprise size	*SIZE*	Natural logarithm of the total assets of the enterprise at the end of the year
	Current ratio	*LR*	Current assets / current liabilities
	The cash recovery rate of assets	*CETA*	Net increase of cash and cash equivalents / total assets at the end of the year
	Business Growth Capability	*TobinQ*	Tobin Q of the enterprise, $Q = (MVT + NTS * NAPS + TD) / TA$ [2]
	Independent director ratio	*Indratio*	Number of independent directors / total number of directors
	Ownership concentration	*Own1*	Own1 Number of shares held by the first largest shareholder / total number of shares

(3) delete samples with an asset-liability ratio greater than 1. An asset-liability ratio greater than 1 means that the company is insolvent and in poor operating condition, so this study removes such samples; (4) to exclude the influence of extreme values, this study uses the 1% and 99% quartiles to reduce the tails of the explained variables. After the above processing, the sample of this paper finally contains 6,169 observations for a total of 1,445 manufacturing companies listed on the Shanghai and Shenzhen stock exchanges in China (unbalanced panel).

Analysis of Descriptive Statistical Results

Descriptive statistics analysis was conducted on the main variables of the entire sample. As can be seen from Table 2, the Z-score of enterprises in the sample period refers to between -0.428 and 2.944, with a mean value of 1.117 and a standard deviation of 0.565, indicating that the Z-score of most manufacturing listed companies is less than the safety value (2.90), which shows that the overall financial situation of manufacturing listed companies is poor and they face greater financial risks. The mean value of the ERI is 0.145, the standard deviation is 0.172, the median value is 0.057, the minimum value is 0.006, and the maximum value is 0.962. Overall, there is a certain degree of variation in the ERI endured by the 29 sub-sectors in China's manufacturing industry.

Further, Table 3 reports the means and standard deviations of the ERI for manufacturing enterprises distinguishing between ownership types, pollution intensities, and cities. The mean values of the ERI for manufacturing enterprises in non-private, high-polluting, and non-first-tier cities are correspondingly higher than those for manufacturing enterprises in private, low-polluting, and first-tier cities, at 0.160, 0.298, and 0.157, respectively, preliminary indications are that the ERI varies across ownership types, pollution intensity, and cities.

Table 2. Descriptive statistics of the main variables.

Variables	Observation	Mean	Std	Min	Max	Median
Z-score	6169	1.117	0.565	-0.428	2.944	1.072
ERI	6169	0.145	0.172	0.00564	0.962	0.0570
SIZE	6169	21.83	1.116	17.64	27.10	21.69
LR	6169	3.088	4.758	0.169	144	1.840
CETA	6169	0.00626	0.104	-0.836	0.706	0.000871
TobinQ	6169	2.388	2.559	0.153	122.2	1.890
Indratio	6169	0.374	0.0546	0.182	0.667	0.333
Own1	6169	0.343	0.142	0.0339	0.900	0.330

Table 3. Descriptive statistics of financial risk and ERI of enterprises in sub-sample.

Variables	Private		Non-private		High-polluting		Low-polluting		First-tier cities		Non-first-tier cities	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Z-score	1.157	0.499	1.000	0.652	1.120	0.605	1.115	0.540	1.165	0.498	1.098	0.591
ERI	0.131	0.164	0.160	0.174	0.298	0.161	0.051	0.090	0.117	0.162	0.157	0.174
Observation	3314		1019		2360		3809		1835		4313	

Empirical Results and Discussion

Panel Regression Results

The common estimation methods for panel data regressions are mainly mixed-effects models, fixed-effects models, and random-effects models. Different regression estimation methods may have diverse effects on the empirical results. Therefore, it is necessary to select a suitable regression method. First, the results of the F test and the LSDV test show that the fixed-effects model is better than the mixed-effects model. Then, the p-value given by the Hausman test is less than 1%, which suggests that the fixed-effects model is better than the random-effects model, and therefore the fixed effects model is chosen. Moreover, the bidirectional fixed effect test for the model in this paper found that the F test statistic F (1444, 4718) = 17.62, and the P-value of the test is less than 1%. Therefore, the bidirectional fixed-effects model is the optimal choice for this paper. Next, the study performed a variance inflation factor test (VIF test). The result shows that the VIF value of each variable does not exceed 1.5, which is much smaller than the empirical rule (VIF value = 10), so there is no need to worry about serious multicollinearity problems.

Table 4 reports the regression results of environmental regulation on the financial risk of manufacturing enterprises. Column (1) is shown that ERI coefficient is -0.171 at a significance level of 1%, indicating that there is a significant negative relationship between ERI and the financial risk of manufacturing enterprises, i.e., strict environmental regulation significantly increases the financial risk of manufacturing enterprises. Columns (2)-(7) gradually add control variables to test the robustness of the measurement results, and the results demonstrate that the measurement results remain robust while controlling for other variables. This shows that Hypothesis 1 is verified.

The main reason is that in recent years, the Chinese government has accelerated the process of environmental protection legislation, strengthened environmental regulation, and more strictly regulated the environmental information disclosure of enterprises, etc. As the key target of environmental regulation, manufacturing enterprises face stricter environmental regulation constraints and bear more unproductive investment costs. On the other hand, Chinese manufacturing enterprises generally rely on resource and energy input for their development [9]. The greater ERI, the higher the cost of using energy-intensive energy and resources for manufacturing enterprises, i.e., higher production costs for enterprises, resulting in narrower profits and thus greater vulnerability to financial distress. In addition, environmental information disclosure becomes an important source of information that influences investors to make investment decisions. Under environmental regulations, manufacturing enterprises are more likely to expose the negative signals of poor environmental performance and violation of environmental regulation. These unsatisfactory signals will reduce investors' willingness to invest, resulting in stronger financing constraints, and thus increased enterprises' financial risk. In a word, ERI has a negative effect on the financial risk of manufacturing enterprises.

Robustness Tests

For ensuring the robustness of the regression results, the following robustness tests are conducted in this paper: First, fixed effects without time dummy variables, and the results are shown in column (8) of Table 5. Second, the regression is divided into year samples. In this study, the samples of 2013-2016, 2014-2016, and 2015-2016 are used for the robustness test, and the results are shown in columns (9)-(11) of Table 5, respectively. The results of the robustness tests show that ERI coefficients are all at a significance level of 5%. These results confirm the robustness of our original analyses.

Heterogeneity Analysis

Ownership Type Heterogeneity

Table 6 reports the regression results of ownership type heterogeneity. First, columns (12)-(13) of Table 6 show the sub-sample regression results for manufacturing enterprises with different ownership types, respectively. According to column (12) of Table 6, the coefficient of ERI for private manufacturing enterprises is -0.098, which is not significant; the coefficient of ERI for non-private manufacturing enterprises is -0.426 at the 5% significance level

Table 4. Regression results of ERI on the financial risk of manufacturing enterprises.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ERI	-0.171***	-0.181***	-0.196***	-0.200***	-0.199***	-0.200***	-0.191***
	(-2.76)	(-2.91)	(-3.22)	(-3.30)	(-3.25)	(-3.25)	(-3.14)
SIZE		-0.101***	-0.095***	-0.104***	-0.122***	-0.122***	-0.123***
		(-3.18)	(-3.00)	(-3.22)	(-3.86)	(-3.86)	(-3.88)
LR			0.012***	0.012***	0.011***	0.011***	0.011***
			(3.68)	(3.62)	(3.57)	(3.57)	(3.63)
CETA				0.169***	0.172***	0.172***	0.180***
				(4.23)	(4.35)	(4.35)	(4.51)
TobinQ					-0.012	-0.012	-0.011
					(-1.12)	(-1.12)	(-1.03)
Indratio						0.067	0.067
						(0.41)	(0.42)
Own1							0.449**
							(2.50)
γ_t	Yes	Yes	Yes	Yes	Yes	Yes	Yes
μ_i	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	1.237***	3.412***	3.235***	3.431***	3.846***	3.820***	3.683***
	(99.46)	(4.98)	(4.73)	(4.92)	(5.57)	(5.44)	(5.10)
Observation	6,169	6,169	6,169	6,169	6,169	6,169	6,169
F-value	44.91	37.75	34.94	32.88	29.28	27.25	27.05
R-squared	0.082	0.093	0.110	0.114	0.119	0.119	0.125

Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively; t value is in parentheses.

Table 5. Robustness test results.

Variables	(8)	(9)	(10)	(11)
	Individual fixed effects	2013-2016	2014-2016	2015-2016
ERI	-0.181***	-0.218***	-0.228***	-0.126**
	(-3.86)	(-3.44)	(-3.74)	(-1.97)
Control variables	Control	Control	Control	Control
γt	No	Yes	Yes	Yes
μi	Yes	Yes	Yes	Yes
Constant	4.656***	4.982***	5.614***	8.141***
	(19.49)	(5.77)	(5.14)	(4.40)
Observation	6,169	4,982	3,799	2,591
F-value	90.67	21.94	23.12	6.871
R-squared	0.119	0.128	0.144	0.109

Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively; t value is in parentheses.

(see column (13), Table 6). This indicates that the effect of ERI on the financial risk of non-private manufacturing enterprises is significant, while the effect of ERI on the financial risk of private manufacturing enterprises is not significant. Hypothesis 2 is verified.

A plausible explanation is that political affiliation is a common phenomenon among global listed enterprises [35], and this phenomenon is particularly prominent among non-private manufacturing enterprises in China. Under environmental regulation, non-private manufacturing enterprises take more responsibility for pollution abatement and pay more for environmental protection investment costs, which to a certain extent increases enterprises' financial risk. In contrast, private manufacturing enterprises are more flexible and autonomous in their investment, which helps to decrease the exogenous impact of environmental regulation. Therefore, the impact of ERI on the financial risk of private manufacturing enterprises is weak.

Pollution Intensity Heterogeneity

This study divides high-polluting manufacturing enterprises and low-polluting manufacturing enterprises for sub-sample regression. According to the regression results in columns (14)-(15) of Table 6, ERI coefficients of high-polluting manufacturing enterprises and low-polluting manufacturing enterprises are -0.220 and -0.043, respectively, and the former is significant at a 1% significance level, while the latter is not significant. This result indicates that ERI has a significant negative impact on the financial risk for high-polluting manufacturing enterprises; for low-polluting manufacturing enterprises, the negative impact is not significant. Hence, Hypothesis 3 is verified.

It is understood that some high-polluting manufacturing enterprises weaken their profitability by bearing huge environmental regulation costs [36], and thus face financial distress. On the other hand, under environmental regulation, high-polluting manufacturing enterprises have production and operation crises such as

Table 6. Regression results of heterogeneity test.

	(12)	(13)	(14)	(15)	(16)	(17)
Variables	Private	Non-private	High-polluting	Low-polluting	First-tier cities	Non-first-tier cities
ERI	-0.098	-0.426**	-0.220***	-0.043	-0.103	-0.238***
	(-1.48)	(-2.17)	(-2.74)	(-0.53)	(-1.01)	(-3.22)
SIZE	-0.167***	0.009	-0.028	-0.165***	-0.197***	-0.086**
	(-5.27)	(0.10)	(-0.53)	(-4.40)	(-4.48)	(-2.26)
LR	0.008**	0.013*	0.017***	0.008**	0.004	0.017***
	(2.57)	(1.80)	(3.42)	(2.56)	(1.41)	(3.38)
CETA	0.186***	0.216*	0.182**	0.166***	0.215***	0.162***
	(4.47)	(1.82)	(2.14)	(3.92)	(3.02)	(3.36)
TobinQ	0.032***	-0.022***	0.032**	-0.018**	-0.020**	0.011
	(4.12)	(-4.00)	(2.13)	(-2.17)	(-2.38)	(1.17)
Indratio	-0.064	0.300	0.149	-0.005	-0.347	0.239
	(-0.34)	(0.81)	(0.63)	(-0.02)	(-1.36)	(1.20)
Own1	0.409**	0.694*	0.458	0.419**	0.754***	0.276
	(2.34)	(1.70)	(1.36)	(2.05)	(2.95)	(1.25)
γt	Yes	Yes	Yes	Yes	Yes	Yes
μi	Yes	Yes	Yes	Yes	Yes	Yes
Constant	4.609***	0.655	1.542	4.600***	5.335***	2.829***
	(6.54)	(0.34)	(1.35)	(5.31)	(5.55)	(3.29)
Observation	3,314	1,019	2,360	3,809	1,835	4,313
F-value	26.74	8.153	13.68	18.47	15.18	17.38
R-squared	0.207	0.144	0.132	0.144	0.207	0.115

Note: *, **, *** indicate significance at the 10%, 5%, and 1% levels, respectively; t value is in parentheses.

shutdown and rectification, de-capacity, and bankruptcy and liquidation [29]. Due to great instability in the production and operation activities, high-polluting manufacturing enterprises are more difficult to obtain financing, thus increasing their financial risks. In addition, in 2012, the Chinese government implemented the "Green Credit Guidelines" policy, which restricts loans from commercial banks to heavily polluting enterprises [14], which will also enhance the financial risk of high-polluting manufacturing enterprises. In contrast, environmental regulation is far less restrictive on the production and operation activities of low-polluting manufacturing enterprises; therefore, the effect of ERI on the financial risk of low-polluting manufacturing enterprises is not significant.

City's Economic Level Heterogeneity

In addition, this study divides the total sample into first-tier cities and non-first-tier cities for a sub-sample study to examine the effect of environmental regulation on the financial risk of manufacturing enterprises. As shown in column (17), Table 6, the coefficient of ERI is -0.238 of manufacturing enterprises in non-first-tier cities at a significance level of 1%; from column (16) of Table 6, it can be seen that the coefficient of ERI is 0.103 of manufacturing enterprises in first-tier cities, but it is not significant. This finding shows that environmental regulation on the financial risk of manufacturing enterprises in first-tier cities is not significant; while environmental regulation significantly increases the financial risk of manufacturing enterprises in non-first-tier cities. Therefore, Hypothesis 4 is verified.

A reasonable explanation is that as "pollution refuges", non-first-tier cities are inclined to develop more polluting industries. As a result, environmental regulation has a more obvious effect on the production and operation of their manufacturing enterprises, thus increasing their financial risks. On the other hand, the first-tier cities, with their optimized industrial structure and mature financial markets, can help manufacturing enterprises to alleviate the cost pressure and financing constraints of environmental regulation. Hence, in relative terms, ERI only plays a negative role in manufacturing enterprises' financial risks in non-first-tier cities.

Conclusions and Policy Recommendations

This study examines the impact of ERI on the financial risk of manufacturing enterprises by using a bidirectional fixed effects model with financial data of listed manufacturing enterprises in China from 2012 to 2016. It is found that: (1) ERI has a significant negative impact on the financial risk of manufacturing enterprises. (2) There is heterogeneity in the effect of ERI on the financial risk of manufacturing enterprises, i.e., ERI plays a significant negative role in the financial risk of non-private, high-polluting, and non-first-tier cities manufacturing enterprises, while in the subsample of private, low-polluting, and first-tier cities manufacturing enterprises, the effect of ERI on the financial risk of such enterprises is not significant.

To achieve a "win-win" situation between environmental regulations and high-quality development of manufacturing enterprises, recommendations can be summarized as follows:

(1) The recommendations for the enterprises. Manufacturing enterprises need to treat environmental regulation policies correctly. Manufacturing enterprises should fully realize that the government will continue to implement environmental regulation policies to strictly restrain the pollution control and emission behaviors of enterprises in the longer term in the future. Therefore, manufacturing enterprises should actively formulate high-quality development strategies to reduce the exogenous impact of environmental regulation policies. Moreover, enterprises should attach importance to all aspects of financial activities and carry out scientific and reasonable budget control to alleviate the negative impact of ERI on enterprises' financial risks.

(2) The recommendations for the government. On the one hand, the government should consider giving certain support to manufacturing enterprises. The policy objective of environmental regulation is to reduce pollution, not to increase the financial risk of enterprises. Therefore, the government can consider giving manufacturing enterprises a certain policy tilt and a certain policy buffer period to help manufacturing enterprises achieve the goal of clean production and green development, to weaken the negative impact of environmental regulation on manufacturing enterprises, and reduce the financial risks faced by them. On the other hand, the government should also consider formulating differentiated environmental regulation policies. Manufacturing enterprises with different ownership types, different pollution intensity, and located in cities with different levels of economic development differ in their coordination and adaptability to environmental regulation and differ in the financing constraints they face. Hence, it is necessary to make differentiated environmental regulations according to different industries and different cities. In addition, the government should flexibly adjust environmental regulation policies based on the assessment of policy effectiveness, to achieve the objectives of environmental regulation policies while reducing the financial pressure of manufacturing enterprises and facilitating the transformation and upgrading of manufacturing enterprises, thus promoting the process of environmental protection and high-quality development of manufacturing enterprises.

Author Contributions

Xiaojie Wang: Funding acquisition, Conceptualization, Writing-Original draft preparation, and Writing-Review; Dongqing Shi: Data curation, Software, Writing-Original draft preparation. Pengcheng Liu: Methodology, Validation, Supervision, Writing-Original draft preparation, and Writing-Review; Bingzhong Ding: Writing-Review & Editing. Yinyin Liang made important contributions to the revision of the manuscript. Pengcheng Liu and Xiaojie Wang contributed equally to this work. All authors have read and agreed to the published version of the manuscript.

Acknowledgments

This work was supported by the Social Science Planning Project of Shandong Province, China (Grant No.17CQXJ04).

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Notes

1. The smaller the indicator, the riskier the business is, and vice versa. A *Z-score*>2.90 indicates a good financial position; a *Z-score*≤1.21 indicates a high risk of insolvency, and a *Z-score* in between is a gray area.

2. *MVT* denotes the market value of tradable shares; *NTS* denotes the number of non-tradable shares; *NAPS* denotes net assets per share; *TD* denotes total debts, and *TA* denotes total assets.

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